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October 20, 1987

Mr. Frank Ciavattieri
New Bedford Project Manager
U.S. Environmental Protection Agency
Region I
JFK Federal Building
Boston, Massachusetts 02203

Subject: Technical Memorandum:
Target Levels of PCBs in Ambient Air During the Pilot
Dredging and Disposal Study: Acushnet River Estuary
Above the Coggeshall Street Bridge

Dear Mr. Ciavattieri:

At your request, enclosed is the Technical Memorandum on target levels of ambient air PCB concentrations during the USACE Pilot Dredging and Disposal Study.

Should you have any questions or comments on the report or our recommendations, please call Allen Ikalainen or Beth Ryan (617-245-6606) directly.

Sincerely yours,

Siegfried L. Stockinger, P.E.
Ebasco Services Incorporated

SLS/mt

cc: M. Amdurer
R. Fellman
A. Ikalainen

EPA WORK ASSIGNMENT NUMBER: 04-1L43

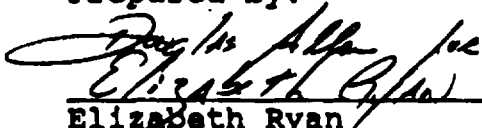
EPA CONTRACT NUMBER: 68-01-7250

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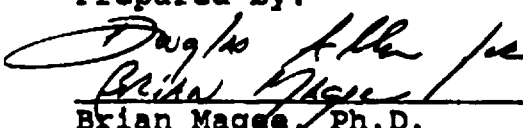
TECHNICAL MEMORANDUM
TARGET LEVELS OF PCBs
IN AMBIENT AIR
DURING THE PILOT DREDGING
AND DISPOSAL STUDY:
ACUSHNET RIVER ESTUARY ABOVE
THE COGGESHALL STREET BRIDGE
NEW BEDFORD HARBOR
BRISTOL COUNTY, MASSACHUSETTS

OCTOBER 1987

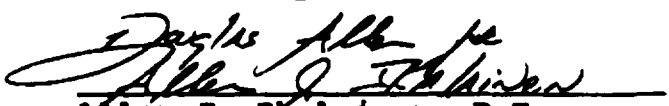
Prepared by:


Elizabeth Ryan
Toxicologist
E.C. Jordan


Prepared by:


Brian Magee, Ph.D.
Senior Toxicologist
E.C. Jordan

Submitted by:


Allen J. Ikalainen, P.E.
Site Manager
E.C. Jordan

Approved by:


Siegfried L. Stockinger, P.E.
Project Manager
Ebasco Services, Incorporated

NOTICE

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE), as part of the Feasibility Study for the New Bedford Harbor Superfund Site, will be conducting a pilot scale dredging operation in the upper estuary of the Acushnet River. The purpose of this Pilot Study is to determine the feasibility of dredging and disposal alternatives for the Superfund site. The nature of the Pilot Study, in particular the removal and storage of PCB-contaminated sediments in a shoreline disposal facility, raises a public health concern over the potential volatilization of PCBs during the dredging and disposal operations and sediment drying processes. In response to this concern, EPA and USACE have identified the need to develop a monitoring program for purposes of collecting "adequate information to insure that public health and the environment are protected during and after the Pilot Study".

Based on current information, the Pilot Study dredging and disposal operations are planned for the area in and adjacent to a small cove located north of the Coggeshall Street Bridge on the New Bedford side of the Acushnet River. Approximately 25,000 cubic yards of contaminated sediments (100-400 ppm PCB) are expected to be removed by hydraulic dredges and pumped through a pipeline to a confined disposal facility (CDF). The contaminated dredge material is to be placed in a 4.5-acre CDF and in a 5-acre contained aquatic disposal site (CAD). In both sites, the contaminated material will be capped by a layer of uncontaminated sediment. Construction and dredging operations and sediment drying processes are expected to last for approximately 6 months (Randall, 1986 and USEPA, 1987).

The USEPA (1987a), has performed preliminary modeling of the drying conditions to estimate the magnitude of the potential release of PCBs from the CDF. Based on the USACE estimate of 13 ppb PCB concentration in the water, releases resulting in off-site concentrations (100 meters distance) ranging from 570 to 680 ng/m³ PCB are possible. The calculations indicate that the CDF could emit a significant quantity of PCB vapors to affect the ambient air concentrations near the source (USEPA, 1987a). Based on this conclusion, it is recommended by the EPA's Exposure Assessment Group (Office of Health and Environmental Assessment), that the target concentrations be calculated based upon a potential exposure duration of six months. The draft report detailing the modeling efforts appears as an appendix to this memo.

The model results indicate the potential for significant releases of PCBs to the air during the Pilot Study operations. To ensure the protection of public health against significant exposure to PCBs, several preliminary target concentrations were developed for EPA's consideration in choosing a final target concentration that will be adequately protective of public health and have minimal impact to the existing conditions at New Bedford Harbor.

2.0 EXPOSURE CONSIDERATIONS

Demographic information reviewed indicates that approximately 2,500 people of all ages reside within a half-mile radius of the proposed CDF location (1985 Census Information). Target concentrations protective of public health were developed based on exposure conditions reflective of a young child/infant. Children/Infants are considered to be more susceptible to contaminant exposure than adults due to their immature immune system and lower body weight. Therefore, PCB concentrations (target levels), considered to be protective for children should also provide an adequate level of protection for adults.

The exposure parameters used to derive air concentrations associated with incremental risk level of 10^{-4} , 10^{-5} , 10^{-6} and 10^{-7} are: continuous exposure (24 hours/day) by a 10 kg child (ages 1-3) to volatilized PCBs, respiratory absorption factor of 100 percent, and a respiration rate of $10 \text{ m}^3/\text{day}$. Target PCB concentrations are calculated for 2 months, 3 months and 6 months exposure durations (0.17, 0.25 and 0.5 years respectively). This range of exposure reflects the expected duration of the Pilot Study operations.

The equation used to derive the PCB air concentration is shown below:

$$RL = CAG \times C \times R \times A/BW \times F \times D/70 \text{ years}$$

where :

- RL = risk level (10^{-4} to 10^{-7})
- CAG = potency factor for PCBs ($7.7 \text{ (mg/kg-day)}^{-1}$)
- C = concentration in mg/m^3
- R = respiration rate ($10 \text{ m}^3/\text{day}$)
- A = absorption factor (1)
- BW = body weight (10 kg)
- F = frequency (continuous)
- D = duration (2, 3 and 6 months; or 0.17, 0.25, and 0.5 years)

Using the above exposure assumptions, the concentrations of PCBs at the receptor locations associated with incremental carcinogenic risks between 10^{-4} and 10^{-7} are calculated and presented in Table 1.

TABLE 1
 TARGET CONCENTRATIONS FOR
 THE NEW BEDFORD HARBOR PILOT STUDY

Incremental Risk Level	Target Concentration Level (ng/m ³)	Target Concentration Level (ug/m ³)
2-Month Exposure Duration		
10 ⁻⁴	5,500	5.5
10 ⁻⁵	550	0.55
10 ⁻⁶	55	0.055
10 ⁻⁷	5	0.005
3-Month Exposure Duration		
10 ⁻⁴	3,600	3.6
10 ⁻⁵	360	0.36
10 ⁻⁶	36	0.036
10 ⁻⁷	4	0.004
4-Month Exposure Duration		
10 ⁻⁴	1,800	1.8
10 ⁻⁵	180	0.18
10 ⁻⁶	18	0.018
10 ⁻⁷	2	0.0018

3.0 DEVELOPMENT OF CANCER TARGET LEVELS

The specific target concentration to use at New Bedford Harbor is determined by identifying the expected exposure duration and the risk level to be achieved. For example, if a 10^{-5} incremental risk level is considered appropriate for a six month exposure duration, the target concentration, obtained from Table 1, is 0.18 ug/m^3 PCBs. This corresponds to an allowable ambient PCB concentration, above background, which is considered to have minimal impact to human health.

The preliminary target concentrations presented in Table 1, provide appropriate health-based guidelines which can be used to establish target concentrations. The final target concentration chosen for this Pilot Study must be based on appropriate exposure information and the desirable risk level.

Available monitoring data indicate that the inhalation incremental carcinogenic risks associated with lifetime exposure to the upwind background concentrations of 10 ng/m^3 (NUS, 1985) is about 10^{-5} . Restricting air releases of PCBs during the dredging operations to concentrations corresponding to risk levels of 10^{-5} to 10^{-7} will, therefore, not significantly increase the current exposure and associated risks for this area.

4.0 METHODS FOR IMPLEMENTING TARGET CONCENTRATIONS

The target PCB concentrations presented above define average air concentrations associated with the various risk levels. That is, daily exposure to the target concentrations over the course of the pilot program would result in the prescribed risk levels. Because PCB emissions into ambient air are expected to vary from day to day depending on weather conditions and the specific daily activities associated with the project, the target level deemed appropriate for the site should be viewed as an average PCB target concentration. However, EPA must be able to monitor the air concentrations daily and make decisions daily regarding the attainment or nonattainment of the average target level.

Jordan recommends two methods for implementing the average PCB target concentration: (1) the 7-day moving average method or (2) the cumulative exposure dose method.

The 7-Day Moving Average Method:

If EPA determines that, for example 0.18 ug/m^3 is an appropriate average target level for a 6 month project, attainment of that average concentration can be monitored by comparison of the target concentration to the 7-day moving average PCB concentration at any receptor monitoring site. When each day's average monitoring result becomes available, it is averaged with the previous 6 days' results. If the daily moving average for any receptor monitoring site exceeds the target concentration of, for instance, 0.18 ug/m^3 , the project would be stopped. Use of the moving average is adequately protective of public health, but also allows short-term daily excursions above the target concentration as long as the concentrations on other days are far below the target concentration.

Cummulative Exposure Dose Method:

The moving average method is easy to implement, but it has one major drawback. Any one week period with an average PCB air concentration exceeding the target concentration will cause the project to be halted. If the air concentrations on the preceeding or following weeks were much lower than the target concentration, it is conceivable that the average air concentration over the entire period of the project would be below the target concentration. Although the moving average method is adequately protective of public health, it may be overly conservative. An alternative approach that allows greater flexibility but is protective of public health is the cumulative exposure dose method.

The cumulative exposure dose over the period of the project that would result from daily exposure of a child to the target concentration is calculated. For instance, for a 1×10^5 excess cancer risk, the cumulative exposure dose is 327 ug. The target concentration is implemented by requiring the cumulative exposure dose at each receptor monitoring site to be at or below 327 ug. The target cumulative dose could be attained in one of several ways:

- o daily exposure to the target concentration;
- o exposure to twice the target concentration for half the project period and exposure to one-half the target concentration for half the project; or
- o exposure to an extremely high concentration for one or a few day(s) (assuming that the 10-day target concentration was not exceeded) and exposure to a very low concentration for most of the project period.

The method allows maximum flexibility while resulting in the same cumulative exposure dose over the project duration. Midcourse changes in the dredging operation could be made to ensure compliance. For instance, if the cumulative exposure dose was approaching the target dose early in the project, design changes could be made to minimize volatilization of PCBs in the remaining days of the project.

Implementation of this method would be simple. Each day's average PCB air concentration in ug/m³ would be multiplied by the assumed 10 m³/day respiration rate to determine the day's exposure dose in ug. A running total could be made each day of the cumulative exposure dose and the remaining allowable exposure dose (ug) prior to meeting the target cumulative exposure dose of, for instance, 327 ug.

5.0 DEVELOPEMENT OF NONCANCER TARGET LEVELS

Due to the inherent variability in air monitoring data and the non-continuous nature of dredging and disposal activities, a range of PCB concentrations in the air can be expected from day to day. It is reasonable to expect varied PCB concentrations during the course of the pilot project including short term exposure to relatively high PCB concentrations. To provide maximum protection to public health, target concentrations were also derived for a short term exposure duration.

There are no acute (1 day) standards or criteria developed for PCBs to provide an upper bound acceptable concentration for acute exposures. However, a 10-day Health Advisory (HA), has been developed by the EPA's Office of Emergency Remedial Response for the protection of human health against the noncarcinogenic effects of PCBs. This value represents an acceptable level of PCB exposure for a period of 10 days or less. It can be applied to the Pilot Project to assess the potential risks associated with PCB release during, for instance, the actual dredging operations. This portion of the Pilot Study involves the removal of contaminated sediments and presents the greatest potential for short term releases of PCBs. This portion of the project is expected to last approximately 14 days.

The 10-day HA (0.01 mg/kg-day) can be expressed in terms of an ambient PCB concentration by factoring in the same exposure assumptions as those used to derive incremental carcinogenic risk estimates (10 kg child, 10 m³/day respiration rate, and continuous exposure to ambient concentrations of PCBs). The PCB concentration calculated below represents the level in the air which would be protective against the noncarcinogenic effects of PCB for exposures of 10 days or less.

$$0.01 \text{ mg/kg-day} = \text{PCB concentration (mg/m}^3\text{)} \times 10 \text{ m}^3/\text{day} \times \\ \times 1/10 \text{ kg body weight}$$

$$\text{PCB concentration} = 0.01 \text{ mg/m}^3 \text{ or } 10 \text{ ug/m}^3$$

Thus, for a single 10 day exposure duration, PCB concentrations up to 10 ug/m³ are considered to be protective of the noncarcinogenic effects of PCB exposure. This standard must be considered simultaneously with the target concentrations based on carcinogenic effects discussed above.

6.0 OTHER CONSIDERATIONS: THE MASSACHUSETTS AIR LEVELS

The Massachusetts Department of Environmental Quality Engineering (DEQE) is in the process of finalizing an Acceptable Ambient Level (AAL) for PCBs. The DEQE considers the AAL to be an "enforceable guideline" although the AALs have not been formally established or promulgated as standards. The AAL currently under peer review is 0.0081 ug/m^3 PCB (8.1 ng/m^3). This value corresponds to a 10^{-5} incremental carcinogenic risk based on a lifetime exposure for a 70 kg adult and a carcinogenic potency factor for PCBs of 4.34 (mg/kg-day)⁻¹. These exposure conditions differ from those expected to occur under dredging operations (2, 3 or 6 month exposure duration for a 10 kg child). Since risk is a function of both exposure to and the concentration of a contaminant, the shorter the exposure duration (i.e., less than lifetime), the "greater" the exposure concentration can be to result in the same level of risk. Thus, the AAL may be overly conservative for purposes of establishing target concentrations for the Pilot Study.

To determine the applicability of the AAL to the Pilot Study, the incremental carcinogenic risk associated with exposure to 0.0081 ug/m^3 was calculated. The risk estimate based on a six month continual exposure for a 10 kg child was calculated to be 4.4×10^{-7} . [This risk estimate is developed using the revised PCB potency factor of 7.7 (mg/kg-day)⁻¹ (USEPA, 1987b)]¹. This risk level falls within the target range of 10^{-4} to 10^{-7} . If the extremely protective incremental risk level of 10^{-7} is considered to be appropriate for the Pilot Study, then the AAL value will be applicable. However, if an incremental risk level of 10^{-4} to 10^{-5} is considered to be appropriate, the AAL may be overly conservative.

7.0 SUMMARY

The following summarizes Jordan's development of health-based target concentrations:

- o The entire Pilot Study operation is expected to occur over a six month duration; including construction, dredging and drying.
- o A recommendation that the target concentrations be calculated based upon a potential exposure duration of six months has been made by EPA's Exposure Assessment Group, based upon modeling results of predictive ambient PCB concentrations.
- o The final target concentration will be determined based on the exposure duration of and the appropriate incremental risk (10^{-4} to 10^{-7}) for the Pilot Project.
- o The preliminary target concentrations presented in Table 1, are considered to be protective of public health against the carcinogenic effects of incremental exposure to PCBs resulting from the Pilot Study operations.
- o The average ambient PCB concentration measured during the entire dredging operation must be equal to or less than the target concentration to attain the desired target risk level.
- o For a single 10-day exposure duration, the maximum allowable PCB concentration is 10 ug/m^3 .
- o Two approaches for implementing the target concentrations are presented. They are the 7-day moving average method and the cumulative exposure dose method.
- o The AAL derived by the Massachusetts DEQE (8.1 ng/m^3) will provide adequate protection, but may be overly conservative if a target risk level of less than 10^{-4} is desired.

LIST OF REFERENCES

Randall, Allen, 1986. "Draft Pilot Study Plan for New Bedford Harbor"; New England Division Corps of Engineers; December 31, 1986.

U.S. Environmental Protection Agency, 1987. "Meeting Convened to Discuss PCB Target Concentrations"; EPA Region I; September 16, 1987.

U.S. Environmental Protection Agency, 1986. "Health Assessment Document for Acetaldehyde"; U.S. Environmental Protection Agency Office of Research and Development, External Review Draft; EPA-600/8-86-015A; April 1987.

NUS, 1985. Draft Report: "Ambient Air Monitoring Program Acushnet River Estuary"; New Bedford, Massachusetts. Volume I. February 1986.

U.S. Environmental Protection Agency, 1987. "New Bedford Harbor Site: PCB Emissions from CDF". From: Seong T. Huang and Kevin Ganahan (Exposure Assessment Group). To: Frank Ciavattieri (New Bedford Harbor Project Manager). October 1987.

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APPENDIX A

**NEW BEDFORD HARBOR
PILOT DREDGING EMISSIONS FROM CDF**



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT - 8

OFFICE OF
RESEARCH AND DEVELOPMENT

SUBJECT: New Bedford Harbor Site; PCB Emissions from CDF

FROM: Seong T. Kwang *S. T. Kwang*
Exposure Assessment Group
Office of Health and Environmental Assessment (RD-689)

Kevin G. Garrahan *Kevin*
Exposure Assessment Group
Office of Health and Environmental Assessment (RD-689)

TO: Frank Ciavattieri
New Bedford Harbor Project Manager
Region 1

In response to concerns raised about the duration of exposure from the pilot dredging project, attached are calculations which assess the emission potential of the CDF during the pilot dredging operations. The calculations indicate that the CDF could emit a significant quantity of PCB vapors to affect the ambient air concentrations near the source. The calculations are based on the PCB concentration of 13 PPB in the water phase contained in the CDF as determined by the Army Corps of Engineers. Although there are many variables which could affect the results of calculations, the estimated concentrations show that the emissions from the CDF could be a significant contributor to the public exposure to PCBs in the ambient air. Hence, the period of CDF operation should be considered in establishing the action levels of ambient air PCB concentrations. Therefore, we recommend that action levels be calculated based upon a potential exposure duration of six months.

Your comments on the assessment are greatly appreciated.

If you have any questions, please do not hesitate to call us.

Attachment

New Bedford Harbor Pilot Dredging Emissions from CDF

The ambient air concentrations in the area affected by the CDF will be estimated. During the stage where the water is kept above the dredged sediment, the Army Corps of Engineers experimentally determined that the concentration of PCBs-1242 in the aqueous phase could be in the order of 13 ppb ($C = \mu\text{g/L}$). The emission rate will be calculated based on this level of contaminant in the overlying water.

The two-resistance mass transfer theory between the aqueous and air phases provides an overall mass transfer coefficient, K_{OL} , of 5.6 cm/hr, with individual mass transfer coefficients of k_{air} for the air phase at 780 cm/hr and of k_{water} for the water phase at 8.13 cm/hr. The Henry's law constant for PCB-1242 of $5.73 \times 10^{-4} \text{ atm m}^3/\text{gmol}$ was used. This value of the overall mass transfer coefficient value checks with Mackay's value published in E&ST (1978) given as 5.7 cm/hr for PCB-1242.

Thus, the emission rate from the CDF occupying an area of approximately $325' \times 325'$ ($= 99\text{m} \times 99\text{m}$) can be calculated from

$$q = K_{OL} \cdot C \quad (1)$$

where q : emission rate $\text{ng/cm}^2.\text{s}$

c : concentration in the water layer, ng/cm^3

with the water phase concentration of 13 ppb ($= \mu\text{g/L} = \text{ng/cm}^3$)

$$\begin{aligned} q &= 13 \text{ ng/cm}^3 \cdot 5.7 \text{ cm/hr} = 74.1 \text{ ng/cm}^2.\text{hr} \\ &= 0.0206 \text{ ng/cm}^2.\text{s} \end{aligned}$$

The on-site concentration levels and the ambient air levels at 100m away from the center of the CDF will be estimated assuming that the average wind speed is 10 MPH ($= 447 \text{ cm/s}$).

- 2 -

1) On-Site Concentration

The box model and the transport model will be used to estimate the concentration levels at the downwind edge of the CDF.

a) Box Model

$$\text{Conc. (ng/m}^3\text{)} = \frac{\text{Flushing time (s)} \times \text{Flux (ng/m}^2\text{.s)}}{\text{Height (m)}}$$

Flushing time for 99m x 99m CDF

$$= \frac{99\text{m}}{4.47\text{m/s}} = 22 \text{ sec}$$

Flux from the total area = 206 ng/m².s

Height = 2m

$$\text{Conc (ng/m}^3\text{)} = \frac{22 \text{ s} (206 \text{ ng/m}^2\text{.s})}{2\text{m}} = 2260 \text{ ng/m}^3$$

b) Transport Model

$$C \text{ (ng/cm}^3\text{)} = \sqrt{2\pi} \frac{q}{\sigma_z} \cdot \frac{x}{u} [1 - \text{erf} \left(\frac{z}{\sqrt{2}\sigma_z} \right)]$$

x is the distance from the upwind edge to the receptor location within the CDF (use 9900 cm)

$$\sigma_z = 450 \text{ cm at 99m}$$

$$u = 447 \text{ cm/s}$$

$$C = \sqrt{2\pi} \frac{0.0206 \text{ ng/cm}^2\text{.s} \cdot 9900 \text{ cm}}{450 \text{ cm} (447 \text{ cm/s})} [1 - \text{erf} \left(\frac{200}{\sqrt{2}(450)} \right)]$$

$$= 0.00170 \text{ ng/cm}^3$$

$$= 1,700 \text{ ng/m}^3$$

Hence the concentration range at the downwind edge of the CDF may be 1700- 2260 ng/m³, when the level of PCB-1242 in the water phase within the CDF, is about 13 ppb. If the contaminated sediment is exposed to the air, emission rate will vary depending upon whether clean cover material is placed on the contaminated sediment or not. Exposed contaminated